Subsurface Barrier Validation with the SEAtrace™ Monitoring System

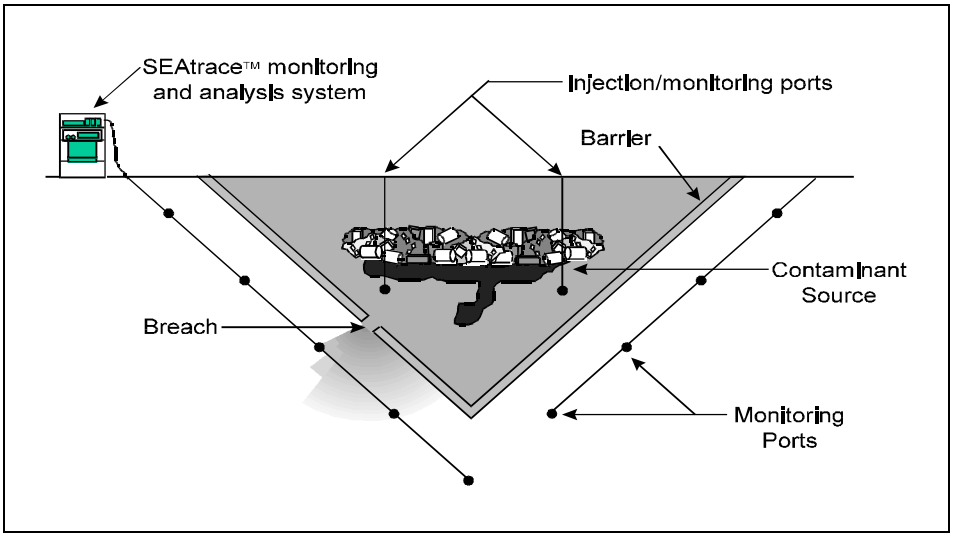
Developer: Science & Engineering Associates, Inc.
Contract Number: DE-AC21-96MC33125
Crosscutting Area: CMST

Problem:

In situ barriers for the containment of high-risk contaminants in soils are currently being developed by the Department of Energy (DOE). These include slurry walls, grout barriers, cryogenic barriers, and other forms of impermeable barriers. Because of their relatively high cost, the barriers are intended to be used in cases where the risk is too great to remove the contaminants, the contaminants are too difficult to remove with current technologies, or the potential for movement of the contaminants to the water table is so high that immediate action needs to be taken to reduce health risks. Consequently, barriers are primarily intended for use in the high-risk sites where few viable alternatives exist to stop the movement of contaminants in the near term. Assessing the integrity of the barrier once it is emplaced, and during its anticipated life, is a very difficult but necessary requirement. Existing-surface based and borehole geophysical techniques do not provide the resolution required to assure the formation of an integral in situ barrier.

Solution:

Science and Engineering Associates, Inc. (SEA) is developing an integrated, real-time, gaseous-tracer-based monitoring/verification system. This system, called SEAtrace™, is able to locate and size leaks with a high degree of accuracy for subsurface barriers which are located in an unsaturated medium. SEAtrace™ uses gaseous-tracer injection, in-field real time monitoring, and real-time data analysis to evaluate barrier integrity.



Benefits:

- Provides early detection by measuring vapor leaks in containment systems where the greatest risk is posed by liquid leaks
- Applicable to any impermeable barrier emplaced in the unsaturated zone
- Inexpensive: uses readily available, non-toxic gaseous tracers; does not require an inordinately large number of sampling points; and injection and sampling points can be emplaced by direct push techniques
- Capable of both assessing a barriers' initial integrity and providing long-term monitoring

Technology:

SEAtrace™ is predicated on the very simple and predictable transport process of binary gaseous diffusion in porous media. Diffusion is an attractive process to utilize for leak detection because the tracer concentration histories measured at locations distant from the source are

highly sensitive to both the size of the breach and the distance from the leak source. This sensitivity allows a global optimization inverse modeling methodology to iterate to leak geometry and location by minimizing errors in the transport calculations. Thus SEAtrace™ is made up of two distinct functional components: a monitoring system and an optimization code.

Monitoring is accomplished with a self-powered, autonomous soil-gas sampling and analysis system which incorporates an infrared gas analyzer. Multiple sample points are located outside the barrier, as well as one or more injection and sample ports inside the barrier. These ports are connected to the gas sampling and analysis system. A tracer gas (typically sulfur hexafluoride [SF_6] or carbon dioxide [CO_2]) is injected into the barrier, creating a large source volume of the tracer. If the barrier has a breach, the tracer will diffuse into the surrounding medium and the exterior vapor ports will sample the soil gas for real-time analysis.

Resulting concentration histories at each of the sample locations, along with soil medium properties, are provided to the global optimization code. The code then iterates to find a best fit solution given the input parameters. The integrated system will produce real-time analysis of leaks within several hours of data collection.

Contacts:

SEA develops innovative environmental characterization, monitoring, and remediation technologies. For information on this project, the contractor contact is:

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DOE's Federal Energy Technology Center supports the Environmental Management - Office of Science and Technology by contracting the research and development of new technologies for waste site characterization and cleanup. For information regarding this project, the DOE contact is:

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